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Racial Differences in Prevalence of Coronary Obstructions Among Men With Positive Nuclear Imaging Studies

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OBJECTIVES The purpose of this research was to compare coronary obstruction between clinically similar African Americans (AA) and white persons undergoing coronary angiography.

BACKGROUND African Americans have higher rates of coronary death than whites, but are less likely to undergo coronary revascularization. Although differences in coronary anatomy do not explain racial difference in revascularization rates, several studies of clinically diverse persons undergoing coronary angiography have found less obstructive coronary disease in AA than clinically similar whites.

METHODS We studied 52 AA and 259 white male veterans who had both a positive nuclear perfusion imaging study and coronary angiography within 90 days of that study in five Department of Veterans Affairs hospitals. We used chart review and patient interview to collect demographics, clinical characteristics, and coronary anatomy results. Before angiography, we asked physicians to estimate the likelihood of coronary obstruction.

RESULTS The treating physicians' estimates of coronary disease likelihood were similar for AA (79.5%) and whites (83.0%); AA were less likely to have any coronary obstruction (63.5% vs. 76.5%, $p = 0.05$) and had significantly less severe coronary disease ($p = 0.01$) than whites. African Americans continued to be less likely to have coronary obstruction in analyses controlling for clinical features, including the physician's estimate of the likelihood of coronary obstruction.

CONCLUSIONS These results suggest that AA have less coronary obstruction than apparently clinically similar whites. Further studies are required to confirm our findings and better understand the paradox that AA are less likely to have obstructive coronary disease and more likely to suffer mortality from coronary disease. (J Am Coll Cardiol 2006;47:2034–41) © 2006 by the American College of Cardiology Foundation

African Americans (AA) are more likely than whites to die of cardiovascular disease, the most common cause of death in both AA and whites (1). The racial difference in mortality rates is especially striking among individuals with established coronary artery disease (CAD). Because in several settings coronary revascularization increases survival in patients with established coronary disease (2,3), it has been a surprising paradox that AA have repeatedly been shown to have lower rates of coronary angiography and coronary revascularization than whites (4–9). This disparity is present in Department of Veterans Affairs (VA) as well as private sector hospitals and persists after adjustment for clinical factors (10,11). These lower rates of revascularization have been associated with lower rates of survival after diagnosis, adjusting for other clinical variables (12).

This difference in revascularization rates may be related in part to the finding that in several settings AA undergoing coronary angiography have been less likely than whites to have severe coronary disease, defined as significant obstructions in the distribution of all three major coronary vessels or the left main coronary artery (13–15). Moreover, AA who have acute ischemia and undergo coronary angiography are

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Abbreviations and Acronyms

AA = African Americans
CAD = coronary artery disease
CDMS = Cardiac Decision Making Study
SAQ = Seattle Angina Questionnaire
VA = Department of Veterans Affairs

more likely than whites to be found to have no obstructive lesions (16). Because there are also racial differences in rates of coronary angiography (4,17), it is possible this is due to selection bias. However, at least one population-based study using electron beam computed tomography found that coronary artery calcium scores, which are a marker for coronary atherosclerosis, are lower in AA than in age- and gender-matched whites (18). This is true both among persons with established cardiovascular disease and among those with no known cardiovascular disease.

These observations suggest there may be important differences in the prevalence of coronary obstruction among clinically apparently similar AA and white populations. If true, there might be important implications for diagnostic evaluation and treatment in these settings. For example, the RAND criteria for appropriateness of coronary revascularization heavily emphasize the presence and number of coronary artery stenoses of at least 70% (19). Indeed, in our prior work using clinically detailed data for other patient populations, adjustment for the presence of stenoses has reduced but not eliminated the magnitude of racial disparities in revascularization rates (10,11). Therefore, we carried out the present analysis of patients participating in the Cardiac Decision Making Study (CDMS) (17). In the CDMS, coronary angiography rates were significantly higher in white (47%) than AA (33%) patients. This difference persisted after adjustment for clinical factors. We wanted to determine whether there are differences in coronary anatomy between white and AA patients who received coronary angiography because of the results of non-invasive testing.

METHODS

Study population. The CDMS is an observational cohort study of self-identified white or AA veterans who underwent non-invasive testing for coronary obstructive disease at one of five participating VA medical centers between August 1999 and January 2001. Study personnel attempted to enroll all veterans who had a nuclear imaging study that suggested coronary ischemia, according to the local interpreter. These studies were performed as part of routine clinical care. Thus, they included a variety of techniques (resting and delayed, various exercise protocols, and various pharmacological stressors) and radionuclides (e.g., single and dual isotope) in keeping with local practice patterns. Details of the recruitment process have been published, (17,20), but we present a brief summary.

We screened 5,278 patients who had a nuclear imaging study, of whom 2,335 (44%) had a positive study. Of these, we excluded 981 for the following reasons: 456 patients (19%) could not be contacted to enroll in the study; 209 (9%) had had a cardiac procedure in the preceding six months; 102 (4%) were not AA or white; 78 (3%) had impaired mental status; 32 (1%) were in another research study determining their cardiac treatment; and 104 (4%) were excluded for miscellaneous other reasons (e.g., the nuclear imaging study was conducted for a compensation and pension evaluation, the patient's hearing was impaired, or the patient was not a veteran). Of the remaining 1,354 patients with positive imaging studies, 329 overtly refused, failed to return their informed consent, or failed to return mailed questionnaires. Thus, 1,025 (75.7%) persons of 1,354 eligible veterans who were contacted agreed to participate. For the present analysis, we restricted our attention to those veterans (n = 318) who had coronary angiography within 90 days after their imaging study. We dropped all women (n = 7) from the analysis, because all were white, potentially confounding our racial comparison.

Data. We reviewed the medical records of each study respondent, obtaining records for non-VA care where possible. Trained nurses who were blinded to both study aims and the race of the patient abstracted patient demographics, cardiac symptoms, and past medical history (including prior myocardial infarction or prior coronary revascularization, angina, congestive heart failure, diabetes, hypertension, renal dysfunction, or chronic obstructive lung disease). The abstractors used the official coronary angiogram report to determine the presence of obstruction in each of the major coronary systems, and whether there was obstruction of the proximal left anterior descending artery. As an indication of the extent to which medical therapy had been maximized for each patient, we used the American College of Cardiology/American Heart Association guidelines for coronary angiography and the management of patients with chronic stable angina (21,22). Thus, we defined maximal medical therapy as antiplatelet therapy, sublingual nitroglycerin, and at least one of the following: beta-blockers, calcium-channel blockers, or long-acting nitrates.

We used patient responses to the Seattle Angina Questionnaire (SAQ) to assess patients' perceptions of anginal stability and frequency (23). To assess the physician's perception of the probability of the patient having CAD, we asked, "On a scale from 0% to 100%, please estimate the probability of CAD in this patient (70% or more narrowing of an epicardial artery)."

We classified coronary obstruction as severe if either the left main coronary artery or all three major coronary systems had a stenosis of 70% or greater. We classified non-severe obstructions as moderate if the proximal left anterior descending artery was involved, and mild if it was not, but if there was at least one coronary obstruction of >70%. We classified coronary obstruction as none if there was no obstruction of >70% (16).

JACC Vol. 47, No. 10, 2006
May 16, 2006:2034–41

Two physicians, a board-certified general internist (J.W.) and a cardiology fellow (M.M.), classified the severity of each nuclear imaging study based on review of the official report, which did not include information about patient race. We categorized the risk of severe coronary obstruction as low, moderate, or high, using a modification of the methods of Bateman et al. (24). In this method, patients with reversible lesions in the distribution of left anterior descending coronary artery or in both the right coronary artery and left circumflex artery were considered to be at high risk, as were patients with increased lung uptake or transient ischemic dilation with exercise or pharmacologic stress. Patients with reversible lesions in just one of the right coronary artery or left circumflex artery were considered to be at moderate risk. Patients whose defects were very small or minimally reversible were considered to be at low risk. Disagreements were resolved by consensus.

We considered the use of more complex scoring systems (25–27). However, these methods require data elements not routinely included in the reports generated at one or more of the five sites participating in the present study. For example, the method of Hachamovitch et al. (25) considers the percent of myocardium that has fixed defects, the percent of myocardium that has reversible defects, and the presence of dyspnea as a presenting symptom, none of which were uniformly available to us. More importantly, these systems were primarily developed to predict coronary disease events such as myocardial infarction or death, not to predict the presence of significant obstructions. In contrast, the Bateman system, although not a validated prognostic method, is an established predictor of coronary angiography (24), and relies solely on the distribution and qualitative severity of reversible defects, along with the presence of transient ischemic dilation or increased lung uptake, each of which is known to be correlated with the presence and severity of coronary obstruction (27). Our study is motivated by our desire to understand racial differences in coronary revascularization rates. Because methods to assess the appropriateness of revascularization are heavily dependent on the number and location of coronary stenosis (19), we elected to use the Bateman approach, rather than one of the more sophisticated predictors of prognosis.

Statistical analysis. We first examined the bivariate relationship of race to coronary obstruction using a chi-square test for trend. We then dichotomized coronary obstruction as any versus no obstructive disease for further analyses. We used *t* tests or chi-square tests as appropriate to compare this dichotomous variable to each of the potential confounders.

To determine the relationship of race to the presence of coronary obstruction controlling for confounding factors, we used logistic regression modeling. We used stepwise (i.e., both forward and backward) selection as implemented in SAS to select variables from among potential confounders, including age, comorbid conditions, previous coronary revascularization, previous myocardial infarction, angina stability and frequency, whether the patient was on maximal medical therapy, and the results of the nuclear imaging study. We used a p value of 0.10 for variables to enter the model, and a p value of 0.10 to remove variables that no longer contributed to the model. This approach tends to retain control variables of marginal significance, which decreases bias in our estimate of the effect of race, with a small cost in increased variance. In our stepwise selection procedure, we forced race and site of care into the model, regardless of their level of significance. Although we treat site as a fixed effect during model selection, our final logistic regression model treats site of care as a random effect to account for the site cluster effect such that patients within the same site might share similar characteristics that are associated with the presence of coronary obstruction (28). Because the physician's global estimate of the likelihood of significant coronary obstruction presumably took into consideration many of the other factors in the model, we present models with and without this variable. To check the robustness of our stepwise procedure, we also performed a backward selection algorithm with a p value of 0.10 for variables to be retained in the model.

All analyses were conducted using SAS statistical software (SAS Inc., Cary, North Carolina). This study was approved by the human studies subcommittee of the VA medical centers where data collection took place, and by the study coordinating center.

RESULTS

Of the 1,025 participants in the CDMS, 311 men (30.3%) had coronary angiography within 90 days of the nuclear imaging study and are included in the present analysis. Fifty-two (16.7%) were AA. Characteristics of AA and white participants are compared in Table 1. We observed several non-significant trends—whites were older and more likely to have had a previous revascularization, while AA were somewhat more likely to have angina reported in the medical record, or to be on maximal medical therapy. African Americans were significantly more likely to have hypertension (92.3% vs. 79.5%, $p = 0.03$). Physician estimates of the likelihood of CAD were similar in whites and AA (mean of 83.0% vs. 79.5%, $p = 0.25$).

In bivariate analyses, AA had less severe CAD than whites (Fig. 1) ($p = 0.01$). In particular, AA were less likely to have severe obstructive disease (39.4% vs. 26.9%) and more likely to have no significant obstructions (36.5% vs. 23.6%).

The rest of the bivariate results (Table 2) treat coronary obstruction as a dichotomous variable—either at least one significant obstruction is present, or there are no significant obstructions. The proportion of patients with CAD increased stepwise with age, from 67.9% of patients <55 years old to 80.5% of those ≥65 years old. The likelihood of a significant obstruction was also greater among patients with prior myocardial infarction or prior revascularization, as well as among patients on maximal medical therapy. No comor-

Table 1. Characteristics of Study Patients by Race

Patient Characteristics	Percent With Characteristic		p Value
	White	AA	
Age (mean, SD)	62.8, 9.6	59.9, 10.9	0.06
Age 20–54 yrs	24.3	34.6	
Age 55–64 yrs	32.1	26.9	0.30
Age 65 yrs or older	43.6	38.5	
Site of care A	16.6	13.5	
Site of care B	19.7	30.8	
Site of care C	18.5	34.6	0.002
Site of care D	27.4	5.8	
Site of care E	17.8	15.4	
Prior myocardial infarction	38.0	33.3	0.53
Prior revascularization	35.4	25.0	0.15
Maximal medical therapy	39.4	50.0	0.16
Angina on chart review	72.3	82.7	0.12
Hypertension	79.5	92.3	0.03
Diabetes mellitus	30.1	26.9	0.65
Renal dysfunction	12.0	17.3	0.29
Congestive heart failure	20.2	21.2	0.88
Chronic obstructive lung disease	25.1	19.6	0.40
Nuclear study, high risk	55.8	50.0	
Nuclear study, moderate risk	37.5	44.2	0.66
Nuclear study, low risk	6.8	5.8	
SAQ frequency score	70.5	65.6	0.26
SAQ stability score	65.4	59.8	0.28
Physician estimated likelihood of obstructive coronary disease (%)	83.0	79.5	0.25

AA = African American; SAQ = Seattle Angina Questionnaire, scale is 0–100, where lower numbers mean more frequent or less stable angina.

bid condition was associated with the presence of CAD. Seattle Angina Questionnaire scores were similar in patients with and without coronary disease for both stability (SAQ stability score 64.3 vs. 64.9, p = 0.90) and frequency (SAQ frequency score 68.4 vs. 73.4, p = 0.18). Physician estimates of the likelihood of obstructive coronary disease were higher in patients who had at least one obstructive lesion (mean of 85.2% vs. 73.7%, p = 0.0002). This was true among AA (mean of 83.2% vs. 74.4%, p = 0.12) and white (mean of 85.5% vs. 73.4%, p = 0.0011) patients.

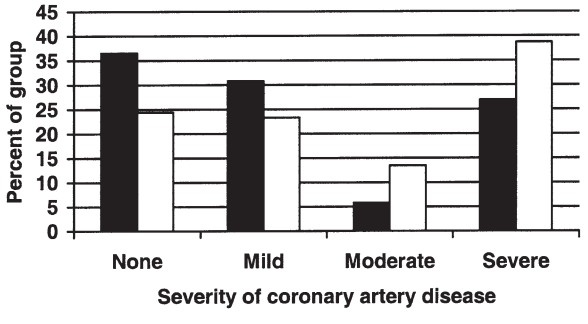

Figure 1. Relationship of race to severity of coronary artery disease. The distribution of the severity of coronary artery disease is significantly different between African Americans (AA) **(solid bars)** and whites **(open bars),** p = 0.01, by Mantel-Haenszel chi-square test for trend: Severe = left main or all three coronary artery systems with significant obstructions; Moderate = one or two systems with obstructions, including the proximal left anterior descending; Mild = one or two systems with obstructions, not including the proximal left anterior descending; None = no obstruction ≥70%.

Table 2. Presence of at Least One Coronary Obstruction by Patient Characteristics

Patient Characteristics	n	Percent With Any Obstruction	p Value
White	259	76.5	0.05
African American	52	63.5	
Age 20–54 yrs	81	67.9	
Age 55–64 yrs	97	71.1	0.03*
Age 65 yrs or older	133	80.5	
Site of care A	49	54.0	
Site of care B	67	91.0	
Site of care C	65	65.2	<0.0001
Site of care D	72	70.3	
Site of care E	54	88.9	
Prior myocardial infarction	114	87.7	<0.0001
No prior myocardial infarction	192	66.7	
Prior revascularization	104	85.6	0.0014
No prior revascularization	205	68.8	
Maximal medical therapy	128	80.5	0.0367
Not on maximal medical therapy	183	70.0	
Angina by chart review	228	75.0	0.6595
No angina on chart review	80	72.5	
Hypertension	253	75.5	0.4052
No hypertension	57	70.2	
Diabetes mellitus	92	70.7	0.3433
No diabetes mellitus	219	75.8	
Renal dysfunction	40	75.0	0.9107
No renal dysfunction	271	74.2	
Congestive heart failure	63	76.2	0.7691
No congestive heart failure	246	74.4	
Chronic obstructive lung disease	75	74.7	0.9144
No chronic obstructive lung disease	235	74.0	
Nuclear study, high risk	166	77.1	
Nuclear study, moderate risk	117	71.8	0.09*
Nuclear study, low risk	20	60.0	

*Mantel-Haenszel chi-square test for trend.

In multivariate analyses (Table 3), race, prior revascularization, and the physician's estimate of the likelihood of CAD were all significantly associated with coronary obstruction at the p ≤ 0.05 level. The white to AA odds ratio for having at least one significant obstruction was 2.77 (95% confidence interval 1.29 to 5.93, p = 0.009). Because physician global estimate of the likelihood of coronary disease presumably incorporates many of the clinical variables, we repeated the analysis omitting that variable. In this analysis previous myocardial infarction and the severity of the defect on nuclear imaging were significantly associated with having obstructive disease, as was prior revascularization. The white-to-AA odds ratio for having at least one significant obstruction was 2.21 (95% confidence interval 1.10 to 4.48, p = 0.028). In both models, study site accounted for significant variation.

DISCUSSION

We found that whites had more severe coronary disease than AA in this population of male veterans with evidence of ischemia on nuclear imaging. In multivariate analysis, AA were less likely to have at least one significant coronary artery obstruction, controlling for demographic and clinical

JACC Vol. 47, No. 10, 2006
May 16, 2006:2034–41

Table 3. Multivariable Odds Ratios for Having at Least One 70% or Greater Stenosis on Coronary Angiography, Adjusted for Site of Care*

Characteristics	With Physician Global Estimate of Risk			Without Physician Global Estimate of Risk		
	Odds Ratio	95% CI	p Value	Odds Ratio	95% CI	p Value
White race	2.77	1.29–5.93	0.009	2.21	1.10–4.48	0.028
Prior revascularization	4.39	1.88–10.24	0.0007	2.21	1.12–4.34	0.023
Prior myocardial infarction	—	—	—	1.96	1.00–3.87	0.053
Imaging defect severity†						
Mild	—	—	—	0.28	0.10–0.80	0.018
Moderate				0.61	0.34–1.10	0.10
Physician estimated risk‡	1.30	1.11–1.52	0.0015	—	—	—

*Candidate variables for the modeling included age, comorbid conditions, previous coronary revascularization, previous myocardial infarction, angina stability, and frequency, whether the patient was on maximal medical therapy, and the results of the nuclear imaging study; †severity of imaging defect does not enter the model when physician global estimate of risk is included; ‡Odds ratio represents the effect of a 10% increase in the physician's estimate of the likelihood the patient will have at least one coronary obstructive lesion ≥70%.

CI = confidence interval.

variables, physician estimates of the likelihood of CAD, and site of care. These results add to the growing body of literature that suggests that despite less frequent use of coronary angiography among AA patients, those AA who undergo the procedure are actually at lower risk for having coronary obstructive disease than whites who undergo the procedure.

There is a substantial literature demonstrating less obstructive coronary disease in AA than among whites drawn from populations undergoing coronary angiography. In an analysis of the Coronary Artery Surgery Study database, Maynard et al. (13) reported that blacks were more likely than whites to have no significant stenoses, and that whites were more likely to have severe disease (i.e., involvement of the left main or parts of all three major epicardial vessels). Similarly, in a study of 6,594 patients undergoing coronary angiography at a single center, Oberman and Cutter (14) found whites more often had multivessel disease than AA. In a multicenter study of patients presenting to emergency departments for chest pain, Johnson et al. (15) found that 45% of AA who underwent coronary angiography had no significant coronary obstructions compared with just 16% of whites who had the procedure. Although large, each of these studies had limited clinical detail and persons were undergoing coronary angiography for a variety of indications. A more recent study limited to persons undergoing coronary angiography during an admission for an acute coronary syndrome (myocardial infarction or unstable angina) had similar results (16). In that study, 19% of AA and 7% of whites admitted for acute myocardial infarction had no coronary artery obstruction of 70% or greater. In the same study, 33% of AA and 17% of whites with unstable angina had no such obstructions. Moreover, these differences persisted after controlling for a variety of clinical variables obtained from chart review. These findings from angiographic studies in clinical populations are reinforced by findings reported by Newman et al. (18) in a population-based study of Medicare beneficiaries participating in the Cardiovascular Health Study. They found that, after controlling for standard atherosclerotic risk factors, older AA had less coronary artery calcium (a marker for coronary obstructive disease) than similar whites, both in the presence and absence of clinical coronary disease (18).

Our study goes beyond these previous studies by adding a standardized assessment of the patients' anginal symptoms and the physician's assessment of the likelihood of CAD to the clinical data available on chart review. Because this physician assessment added importantly to the model, we believe it is a particularly valuable contribution of the present study.

Although the present study was a prospective study of patients with a similar course to angiography and used a wide variety of data sources to gain a comprehensive clinical picture, it had a number of limitations. First, not all patients with a positive imaging study underwent coronary angiography. Thus, it is possible that physicians are simply less able to select AA patients at high risk for coronary disease, either because the diagnostic tests in use are less accurate in this population, or because cross-cultural communication differences make it harder to interpret the clinical history that is the cornerstone of clinical decision making (29,30). Alternatively, physicians may utilize the epidemiologic evidence regarding higher death rates among AA with CAD and may thus use lower thresholds to refer them to angiography. However, this trend was not seen in a study in which primary care physicians viewed videotapes of actors that portrayed identical clinical stories. In that study, Schulman et al. (31) found the physicians were less likely to refer black women for coronary angiography than black or white men or white women. Moreover, in the present study, AA were less likely to undergo coronary angiography than whites, even after controlling for clinical differences (17). Despite this, we must acknowledge that there may be important, though unidentified, factors that influence whether AA patients undergo coronary angiography.

Second, because this was a study of actual practice, the clinicians who provided this care were aware of the patients' race, which could have allowed a systematically biased

interpretation of the diagnostic studies. Future studies could consider blinded interpretation of the original clinical material. It is also possible that clinicians could have tailored their estimates of the likelihood of coronary obstruction to justify the actions that they took. However, the clinician survey did not ask the physician to identify race, and race was not mentioned in informed consent documents.

We also note that there was significant variation among sites in the frequency with which coronary angiograms were performed, as well as the proportion of persons who had significant coronary obstructions. Because we studied actual clinical practice, it is not surprising that the threshold for coronary angiography, and thus the prevalence of coronary obstruction, would vary among sites (32,33). Variation in imaging techniques and variability in the threshold for calling a study positive may have also contributed to variations among sites. Our analytic technique allowed us to compare the results in AA and whites, adjusting for any site effect. Moreover, we believe that this study of actual clinical practice is an important approach to studying the racial differences in care that have been described in practice. That said, we believe that studies applying standardized protocols to well-characterized populations of diverse ethnicity are also important, because the interpretation of studies of actual practice are frequently affected by differences in practice such as those we observed.

Fourth, although our clinical data included patient symptoms, demographic characteristics, history of CAD, and a physician estimate of the likelihood of coronary disease for each patient, it is possible that additional clinical data would identify differences for which we did not account, but which would explain the discrepancy. However, our team of experienced clinicians and review of the literature did not identify other such important data elements. Further, we expect that the physician global estimates of risk would have incorporated any such information. Related to this, we acknowledge that our use of a simple, readily reproducible method for classifying the results of the nuclear imaging study is likely less predictive of coronary outcomes than more complex scoring systems (25). This emphasizes that although the present study demonstrates that AA may have less obstructive coronary disease than apparently clinically similar whites, it is still true that AA are more likely than whites to die of ischemic heart disease, even adjusting for coronary anatomy (12,34).

Finally, although the difference in coronary obstructive disease prevalence by race is statistically significant, confidence intervals are wide because of the relatively small number of AA patients included in the study. That is, although the point estimates of the influence of race on prevalence are clinically important, the small sample size precludes a very precise estimate of their magnitude. Moreover, the fact that the study population was drawn from Department of Veterans Affairs hospitals resulted in an entirely male study population. Clearly, future studies should include larger numbers of patients, particularly women and AA.

As a group, our studies, and the studies cited above, suggest that AA with clinical CAD have fewer obstructive lesions than whites with similar clinical findings. These studies are also consistent with the possibility that AA are just as likely to have CAD as whites, but physicians are less able to select the AA patients who have the obstructive disease. However, we found that physician-estimated risk of CAD was as good a predictor of CAD in AA as it was in white patients. We note that previous reports of the operating characteristics of nuclear imaging studies typically have not examined whether sensitivity and specificity of these studies varies by patient race, although age and gender do appear to affect tests for ischemia (27,35). Moreover, studies have shown that electrocardiogram criteria for left ventricular hypertrophy are less accurate among AA than they are among whites (36). Thus, we believe that studies of the operating characteristics of diagnostic tests in diverse populations are needed.

Together with studies suggesting that AA are *more* likely to die from coronary disease (34), these data suggest there are important differences in the clinical manifestations of CAD among AA and whites. This disconnect between coronary anatomy and cardiovascular disease mortality is perhaps not surprising, because epicardial vessel stenosis is a far-from-perfect predictor of adverse outcomes (27,37). Improved understanding of the diversity of factors influencing coronary events may allow for better understanding of this disconnect (38). There is some evidence that the construct known as race, although clearly a social and not scientific construct (39), does identify groups with differing responses to some therapies (40,41). Research focused on mechanisms of disease may allow better understanding of racial differences by decreasing reliance on "race" as a surrogate for groups of patients with important clinical differences in the behavior of cardiovascular disease.

How should these results affect the interpretation of the numerous studies demonstrating racial disparities in use of angiography? For example, in this same study cohort, we have previously reported what we termed "disparate" use of angiography, which was not explained by patient demographics (except race), clinical characteristics, patient beliefs, or physician perceptions of patients' personal characteristics, but was associated with physicians' gestalt clinical assessments of patients (e.g., ratings of the patient's probability of CAD and the importance of angiography). The findings in the present analysis suggest that the physicians' clinical assessments of the likelihood of CAD, and the benefit of coronary angiography, which varied by race in the overall CDMS cohort, may have led to *appropriately* lower use of coronary angiography among AA. This is not to say that the enormous literature demonstrating racial differences in cardiac procedure use simply reflects unmeasured clinical differences. However, it does emphasize the difficulty of interpreting such differences in real world settings. In

particular, it emphasizes that focusing entirely on how coronary stenoses are treated likely will not address the problem (or at least much of the problem) of racial differences in coronary disease outcomes.

In summary, we have demonstrated that AA were less likely to have obstructive coronary disease in a population of patients whose clinical presentation caused them to undergo nuclear perfusion imaging and who had an imaging result that suggested reversible ischemia. We believe that these data call for increased efforts to better understand the best diagnostic and therapeutic approach to the management of CAD in the AA population. It may be more important for future research to clarify the most appropriate approach to managing CAD in different populations than to focus solely on racial differences in patterns of utilization of invasive procedures. Continuing the latter would give the implicit message that comparing rates of procedure use is the key measure of whether AA and white patients receive equally high-quality care for CAD. These results suggest that the issue is more complicated.

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